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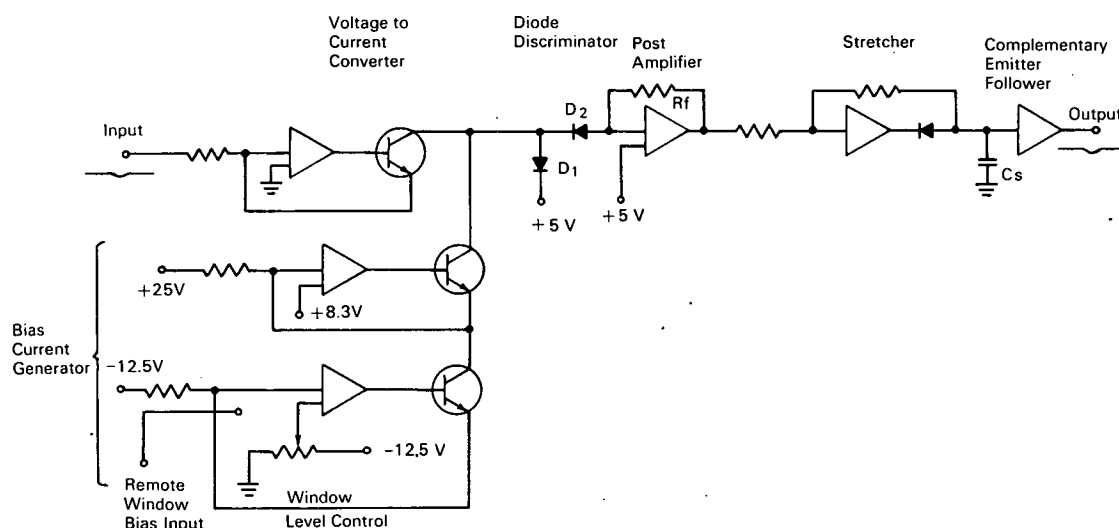


# AEC-NASA TECH BRIEF



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## Transistor Biased Amplifier Minimizes Diode Discriminator Threshold Attenuation



### The problem:

Diode nonlinearity in biased amplifiers causes considerable signal attenuation above the diode threshold level. When the threshold diode begins to conduct, the diode impedance is not negligible relative to the source impedance, resulting in nonlinear signal attenuation near the diode threshold.

### The solution:

A transistor biased amplifier in which the biased diode discriminator is driven by a high impedance (several megohms) current source, rather than a voltage source with several hundred ohms output impedance. This high impedance input arrangement makes the incremental impedance of the threshold diode negligible relative to the input impedance. In this configuration, the output current (and voltage) of the amplifier is a linear function of the input current

over a large dynamic range, quite independent of the threshold diode impedance.

### How it's done:

The input voltage pulses are converted to current pulses by the voltage-to-current converter circuit, which consists of an operational amplifier with a Darlington Pair output. The current pulses are applied to the diode discriminator circuit, consisting of  $D_1$  and  $D_2$ . Diode  $D_1$  quiescently conducts a bias current which is adjustable.  $D_2$  is quiescently non-conducting, until the input signal exceeds the threshold bias at  $D_1$ . At this time,  $D_1$  is completely cut off and the signal, in excess of the threshold level, flows through  $D_2$  into the post amplifier. The post amplifier consists of an operational amplifier whose input is essentially grounded (grounded base input amplifier). The post amplifier converts the excess current signal

(continued overleaf)

to a voltage signal. The open loop gain of the amplifier is kept high due to a bootstrap amplifier configuration. The gain of the amplifier circuit can be adjusted by changing the value of  $R_f$ . For example: for a gain of 10,  $R_f = 10$  Kohms; for a gain of 5,  $R_f = 5$  Kohms, etc. This stage is designed to provide a fast rise time to prevent pulse amplitude distortion at high bias levels in the system. The output of the post amplifier is fed through a stretcher circuit to reproduce the original shape of the voltage pulse at the input to the voltage-to-current converter. This stretcher circuit is not required if the input pulses are square wave rather than R-C clipped. The output of the stretcher circuit is tied to a complementary emitter follower, which is used effectively as a cable driver.

The threshold bias is produced by the bias current generator, which consists of two operational amplifiers and two feedback amplifiers. The bias reference is variable from ground to  $-10$  volts. The reference to the bias current generator can be supplied either internally or externally (in which case a ramp waveform generator can be used). Internally the reference window is variable by the window level control. The output of the bias current generator is tied to the diode discriminator circuit and controls the threshold level of the system.

#### Notes:

1. Selection of the diodes ( $D_1$  and  $D_2$ ) for the diode discriminator is not necessary, since the conductance characteristics of the diodes have no effect on the basic operation of the circuit.

2. This circuit can also be used as a linear gate by applying a fixed current pulse rather than variable DC current to the discriminator diode  $D_1$ .
3. Reference: *Nuclear Instruments and Methods* 32, (1965), p. 147-151.
4. Inquiries concerning this innovation may be directed to:

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#### Patent status:

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